CUTTING DEVICE FOR CUTTING TISSUE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority of United States Provisional Application No. 61/318,803, filed 30 March 2010, the contents of which being hereby incorporated by reference it its entirety for all purposes.

FIELD OF THE INVENTION

[0002] The present invention refers to the field of medical devices, in particular to the field of medical devices that can be used to cut tissues and to release trigger finger.

BACKGROUND OF THE INVENTION

[0003] Trigger finger and trigger thumb are conditions affecting the movement of the tendons as they bend the fingers or thumb toward the palm of the hand. This movement is called flexion.

[0004] The tendons that move the fingers are held in place on the bones by a series of ligaments called pulleys **130** (see **Figure 29**). These ligaments form an arch on the surface of the bone **145** that creates a sort of tunnel for the tendon **140** to run in along the bone **145**. To keep the tendons **140** moving smoothly under the ligaments, the tendons **140** are wrapped in a slippery coating called tenosynovium **135**. The tenosynovium **135** reduces the friction and allows the flexor tendons **140** to glide through the tunnel formed by the pulleys **130** as the hand is used to grasp objects.

[0005] Triggering is usually the result of a thickening in the tendon **140** that forms a nodule, or knob. The pulley **130** ligament may thicken as well. The constant irritation from the tendon **140** repeatedly sliding through the pulley **130** causes the tendon **140** to swell in this area and create the nodule. Rheumatoid arthritis, partial tendon lacerations, repeated trauma from pistol-gripped power tools, or long hours grasping a steering wheel can cause triggering. Infection or damage to the synovium causes a rounded swelling (the nodule) to form in the tendon. Triggering can also be caused by a congenital defect that forms a nodule in the tendon. The condition is not usually noticeable until infants begin to use their hands.

[0006] The symptoms of trigger finger or thumb include pain and a funny clicking sensation when the finger or thumb is bent. Pain usually occurs when the finger or thumb is bent and straightened. Tenderness usually occurs over the area of the nodule at the bottom of the finger or thumb. The clicking sensation occurs when the nodule moves through the tunnel

formed by the pulley ligaments. With the finger straight, the nodule is at the far edge of the surrounding ligament. When the finger is flexed, the nodule passes under the ligament and causes the clicking sensation. If the nodule becomes too large it may pass under the ligament, but becomes stuck at the near edge. The nodule cannot move back through the tunnel, and the finger is locked in the flexed trigger position.

[0007] The usual solution for treating a trigger digit is percutaneous release or surgery to open the pulley that is obstructing the nodule and keeping the tendon from sliding smoothly. In the case of surgery, a relatively large incision is made and the longitudinal release of the tendon sheath is performed using a scalpel. Due to the large incision needed, this may increase the risk of infection and thus prolong the recovery. As for the percutaneous release, a needle is used to release the locked finger.

[0008] Unfortunately, there is a high risk of damaging the digital artery, nerve and also slitting of the underlying tendon due to the direction of insertion. A non surgical method would include the injection of a steroid hormone, such as cortisone, into the tendon sheath. This can decrease the inflammation and shrink the nodule to relieve the triggering, but the results will probably be short lived.

[0009] Thus, it is an object of the present invention to develop further methods and devices which can be used in the treatment of trigger fingers and which overcome at least some of the problems referred to above.

SUMMARY OF THE INVENTION

[0010] In one embodiment, the present invention refers to a cutting device for cutting tissue. This cutting device comprises a sleeve having a first end and a second end. The sleeve may comprise a slit extending from a position at the first end of the sleeve. The first end of the sleeve may be shaped to allow insertion of the sleeve between two tissue layers. Further comprised may be a cutting rod carrying a cutting blade at a first end, the cutting rod being insertable into the sleeve through the second end of the sleeve and being movable within the sleeve. The cutting rod may be positioned within the sleeve so that the cutting blade can protrude through the slit of the sleeve. The cutting device may further comprise a support rod, the support rod being insertable into the sleeve through the second end of the sleeve and being movable within the sleeve. The cutting rod and the support rod may fit together into the sleeve. When the cutting rod and the support rod are arranged together within the sleeve the cutting blade of the cutting rod is protruding through the slit of the sleeve.

[0011] In a further embodiment, the cutting rod and the support rod may be movable independently of each other within the sleeve and insertable in the sleeve.

[0012] In a further embodiment, the cutting rod and the support rod may fill out substantially the entire space of the sleeve when fully inserted into the sleeve during use.

[0013] In a further embodiment, the shape of the cutting rod and the shape of the support rod can be the same or different from each other.

[0014] In one embodiment, the sleeve may be round and the cutting rod and the support rod may have a semicircular shape.

[0015] In another embodiment, the first end of the sleeve comprises a tip with a tapered shape. For example, in one embodiment, the first end of the sleeve may comprise a tip beveled along a vertical axis of the first end.

[0016] In another embodiment, the cutting device of the present invention may further comprise a housing comprising a first end and a second end. The housing can be connected at the first end to the sleeve. The housing may comprise a movable cutter holder and a movable support rod holder. The cutter holder may support the cutting rod and the support rod holder supports the support rod. The cutter holder and the support rod holder may be movable independently from each other. During use, a movement of the cutter holder within the housing allows moving the cutter rod within the sleeve and a movement of the support rod holder allows moving the support rod within and out of the sleeve.

[0017] In another embodiment, the first end of the first housing may be closed with a front cap which is connected to the sleeve and the second end may be closed with an end cap.

[0018] In another embodiment, the cutter holder and the support rod holder may be movably supported by a guiding member. The guiding member can be comprised within the housing.

[0019] In still another embodiment, the cutting device further may comprise a tensible member. The tensible member may be positioned between the first end of the first housing and the cutter holder such that a movement of the cutter holder towards the first end of the first housing cocks the tensible member and positions the cutter holder in a cocked position.

[0020] In another embodiment, the cutting device can further comprise at least one side guide mounted at a side of the housing. The side guide can comprise an engaging region located near the first end of the housing. A protrusion located at at least one side of the cutter holder engages the engaging region of the at least one side guide through an opening of the housing to keep the cutter holder in the cocked position when the tensible member is cocked.

[0021] In another embodiment, the cutting device comprises two side guides wherein the two side guides are positioned at opposing sides of the housing.

[0022] In another embodiment, the cutter holder further comprises at least one slit separating the cutter holder into a central core region and a side member. The central core region may support the cutting rod and may provide a contact region for the tensible member. The side member may comprise the protrusion which engages the engaging region of the at least one side guide to keep the cutter holder in the cocked position when the tensible member is cocked. The side member may be movable towards the central core region from which it is separated by the slit upon exerting pressure on the side member; wherein a movement of the side member of the cutter holder towards the central core region allows to uncock the cutter holder from its cocked position by disengaging the connection between the protrusion and the side guide. Uncocking the tensible member and thus the cutter holder results in the cutter holder to move towards the end cap of the cutting device. During this backwards movement the cutting rod with the raised cutting blade moves backwards within the sleeve. During this movement, the protruded cutting blade cuts the overlying tissue layer.

[0023] In another embodiment, the cutter holder may comprise two slits separating a section of the cutter holder into a central core region and two side members which are located at opposing sides of the cutter holder.

[0024] In still another embodiment, the second end of the housing may comprise a first opening for inserting a control rod into the device. The first opening may be positioned to allow the control rod to engage the cutter holder and to move the cutter holder towards the first end of the housing when inserted into the device.

[0025] In another embodiment, the second end comprises a second opening for inserting a retrieval rod into the cutting device or for inserting a control rod into the cutting device. The second opening may be positioned to allow a retrieval rod to engage the support rod holder and to move the support rod holder towards the second end of the housing when inserted into the device and thus moving the support rod supported by the support rod holder out of the sleeve. Furthermore, the second opening may be positioned to allow the control rod to move the support rod holder towards the first end of the housing and thus moving the support rod supported by the support rod holder into the sleeve.

[0026] In another embodiment, the cutting device may further comprise a support rod guiding member connected to the support rod and comprising a through hole extending from one end of the support rod guiding member to the other end.

[0027] In still another embodiment, the cutting rod may be adapted to fit through the through hole of the support rod guiding member.

[0028] In another embodiment, the sleeve may be connected to a positioning member. The positioning member allows positioning of the sleeve at a specific position in a tissue of a subject.

[0029] In another aspect, the present invention is directed to a control rod for use in a cutting device of the present invention. The control rod may comprise a first end and a second end and comprises a first section and a second section. The first and the second section may have different diameters. The diameter of the first section located at the first end of the rod may be smaller than the diameter of the second section following the first section.

[0030] In another embodiment, the control rod further comprises a handle located at the second end of the control rod.

[0031] In still another embodiment, the diameter of the first section of the control rod may be adapted to be insertable through the first opening of the second end of the housing of the cutting device and the diameter of the second section may be adapted to be larger than the diameter of the first opening of the second end of the housing of the cutting device.

[0032] In another embodiment, the diameter of the second section of the control rod may be adapted to be insertable through the second opening of the second end of the housing of the cutting device.

[0033] In another aspect, the present invention is directed at a retrieval rod for use in a device of the present invention. The retrieval rod may comprise a first end and a second end. The retrieval rod may comprise an engaging member at the first end of the retrieval rod for engaging the support rod holder.

[0034] In another embodiment, the retrieval rod may further comprise a handle located at the second end of the control rod.

[0035] In another embodiment, the engaging member of the retrieval rod may comprise a thread.

[0036] In another aspect, the present invention is directed to a support rod guiding member for use in a cutting device of the present invention. The support rod may comprise a through hole extending from one end of the support rod guiding member to the other end.

[0037] In another aspect, the present invention is directed to a system for cutting tissue. The system may comprise a cutting device of the present invention, a control rod of the present invention, and a retrieval rod of the present invention.

[0038] In another embodiment the system may further comprise an ultrasound device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] The invention will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the accompanying drawings, in which:

[0040] **Fig. 1** shows a schematic view of an embodiment of cutting device.

[0041] **Fig. 2** shows an enlarged view of a sleeve **3100** and a positioning member **3004** of an embodiment of a cutting device. The inset in Figure 2 shows an enlarge view of the first end of the sleeve **3100**.

[0042] **Fig. 3** shows different embodiments of tips **1**, **3002** connectable to a sleeve.

[0043] **Fig. 4** shows a schematic view of a support rod guiding member.

[0044] **Fig. 5** shows a schematic view of a cutting rod.

[0045] **Fig. 6** illustrates different shapes which can be used for a cutting rod **2** and a support rod 6.

[0046] **Fig. 7** shows a perspective view of an embodiment of a cutting device.

[0047] **Fig. 8** shows an exploded perspective view of a cutting device from two different angles.

[0048] **Fig. 9** shows a schematic view of a support rod holder **7**, and a cutter holder **8** from the bottom.

[0049] **Fig. 10** shows a schematic view of an assembly of support rod holder **7**, a cutter holder **8**, and guiding member **9**.

[0050] **Fig. 11** shows a schematic side view of a cutting device without a side guide **12** and a tensible member **5**.

[0051] **Fig. 12** shows a photograph and a schematic side view of a cutting device without the side guide **12** but including the tensible member **5**.

[0052] **Fig. 13** shows a photograph and a schematic oblique view of a cutting device.

[0053] **Fig. 14** shows a schematic view of a cutting rod **2**.

[0054] **Fig. 15** shows a schematic view of a support rod **6**.

[0055] **Fig. 16** illustrates a schematic view of a support rod holder **7** showing the front side and back side of a support rod holder **7**.

[0056] **Fig. 17** shows a schematic top view of a support rod holder **7** and support rod **6**.

[0057] **Fig. 18** shows a schematic front view and back view of a front cap **11** of a housing 10.

[0058] **Fig. 19** shows a perspective view of a sleeve **3**.

[0059] **Fig. 20** shows a schematic view of a tangible member, namely a spring **5**.

[0060] **Fig. 21** shows a schematic view of an end cap **4** of a housing **10**.

[0061] **Fig. 22** shows different perspective views of a cutter holder **8**.

[0062] **Fig. 23** shows a schematic view of a guiding member **9**.

[0063] **Fig. 24** shows a schematic view of a housing **10**.

[0064] **Fig. 25** shows a schematic view of a side guide **12**.

[0065] **Fig. 26** shows a schematic view of a retrieval rod **500**.

[0066] **Fig. 27** shows a schematic view of a control rod **550**.

[0067] **Fig. 28** illustrates the different sequences during the use of the cutting device described herein. The dotted line labelled with "A" indicates the position for the cross-sectional illustration (Section A-A) of the cutting device shown under the top view of the cutting device.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0068] In a first aspect the present invention refers to a cutting device **100** for cutting tissue. In one embodiment, the cutting device **100** is for releasing a trigger finger. Examples of different embodiments of cutting devices are shown for example in **Figure 1,** 7 and **8**. In general, a cutting device **100** of the present invention comprises a sleeve **3, 3100** having a first end and a second end. The term sleeve refers in general to a tube like structure, i.e. a hollow axle. A sleeve is designed to fit over another part or parts. The sleeve **3, 3100** may comprise a slit **31, 3110** extending from a position at the first end of the sleeve **3, 3100**. The first end of the sleeve **3, 3100** may be shaped to allow insertion of the sleeve between two tissue layers. Further comprised may be a cutting rod **2, 3000** carrying a cutting blade **13, 3001** at a first end, the cutting rod **2, 3000** being insertable into the sleeve **3, 3100** through the second end of the sleeve **3, 3100** and being movable within the sleeve **3, 3100**. The cutting rod **2, 3000** may be positioned within the sleeve **3, 3100** so that the cutting blade **13, 3001** can protrude through the slit **31, 3110** of the sleeve **3, 3100**. The cutting device may further comprise a support rod **6, 3201**, the support rod **6, 3201** being insertable into the sleeve **3, 3100** through the second end of the sleeve **3, 3100** and being movable within the sleeve **3, 3100**. The cutting rod **2, 3000** and the support rod **6, 3201** may fit together into the sleeve **3, 3100**. When the cutting

rod **2, 3000** and the support rod **6, 3201** are arranged together within the sleeve **3, 3100** the cutting blade **13, 3001** of the cutting rod **2, 3000** is protruding through the slit **31, 3110** of the sleeve **3, 3100**. In the context of various embodiments, the term "cutting device" may be interchangeably referred to as "cutter device", and the term "cutting rod" may be interchangeably referred to as "cutter rod".

[0069] To use the above cutting device, a small transverse skin incision is made in the proximity of the affected area in which it is intended to cut the pulley **130**. Prior to the insertion of the first end of the sleeve **3, 3100** of the cutting device **100** into the incision, the cutter rod **2, 3000** should be in the fully inserted position within the sleeve **3, 3100**. As long as the support rod **6, 3201** is not fully inserted into the sleeve the cutting blade **13, 3001** will not protrude through the slit **31, 3110** of the sleeve **3, 3100**.

[0070] Under the guidance of an ultrasound machine, the sleeve **3, 3100**, with the cutter rod **2, 3000** fully inserted, is inserted between the pulley **130** and the tendon **140** (see **Figure 29**). In doing so, the pulley **130** will be stretched taut. This will facilitate the slitting of the pulley **130** thus releasing the trigger finger. When in position, the support rod **6, 3201** is inserted fully into the sleeve **3, 3100**. This will force the cutting blade **13, 3001** to protrude and pierce through the pulley **130**. The cutter rod **2, 3000** is then pulled backward to longitudinally slit the pulley **130**. This step may be repeated if the desired release is not achieved in the first cut. When the desired release has been achieved, the support rod **6, 3201** is withdrawn to allow the blade **13, 3001** on the cutter rod **2, 3000** to be retracted and the cutting device **100** is withdrawn as a whole. This will prevent any unnecessary damage to the surrounding tissues, such as the digital artery, a nerve and the underlying tendon. The above device cannot only be used for cutting the pulley to release a trigger finger but can also be used for cutting of other tissue layers.

[0071] **Figure 1 and 2** illustrate an embodiment of a cutting device **100** of the present invention. In this embodiment, the circular shaped sleeve **3100** of the cutting device 100 is connected to a positioning member **3004**. The sleeve **3100** can be connected to the positioning member **3004** in any known manner. For example, the sleeve **3100** can be welded to the positioning member **3004** or can be removably inserted into the positioning member **3004**, for example by a push-fit mechanism.

[0072] The positioning member **3004** can have any shape which allows the operating personnel to easily hold and move the connected sleeve **3100** during its insertion into the affected area. In the embodiment illustrated in **Figures 1 and 2** the positioning member **3004** has a T-shape wherein the sleeve **3100** is connected to the horizontal bar of the T-shaped positioning member **3004**. The positioning member **3004** comprises a through-hole at the

point of connection between the sleeve **3100** and the positioning member **3004** which allows inserting and removing of the cutter rod **3000** and the support rod **3201**.

[0073] To aid the insertion of the sleeve **3**, **3100** the first end of the sleeve ends can have a tapered shape. In one embodiment a tip is fixed to the first end of the sleeve. Examples of such tips are illustrated in **Figure 3**. **Figure 3(A)** shows a tip having the shape of a cone **3002**. **Figure 3(B)** shows a tip bevelled along a vertical axis. However, the tip can also have other shapes which allow to more easily insert the sleeve at the affected are of the body.

[0074] The tips shown in **Figure 3 (A)** and **(B)** comprise a connecting collar **17**. The connecting collar **17** allows attaching the tip **1, 3002** to the open end **32** of a sleeve (see e.g. inset in **Figure 2** or **Figure 19**). The collar serves as a push fit fitting and is protruding from the end of the tip which is to be inserted into the sleeve opening. A pointed tip also assists to separate the different tissue layers from each other when inserting it with the pointed end of the tip ahead between the tissue layers. In the present invention, separating the different tissue layers from each other also avoids that the tissue layer which lies on the side of the sleeve through which the cutting blade does not protrude, in the present case the tendon, gets damaged during the cutting process.

[0075] **Figure 1** shows the situation in which the cutter rod **3000** carrying the cutting blade **3001** near its first end is protruding through the slit **3110** of the sleeve **3100**. The cutting blade **3001** of the cutter rod **3000** only protrudes through the slit **3110** of the sleeve **3100** in case the support rod **3201** (see **Figure 4**) is inserted into the sleeve **3100**. The cutter rod **3000** is dimensioned to rest in a lower position within the sleeve **3100** if the support rod **3201** is not inserted into the sleeve. In the embodiment illustrated in **Figure 1** and **Figure 4**, the support rod **3201** and the cutter rod **3000** have a semicircular shape. Together they form a circle which fills almost the entire space of the hollow sleeve when they are inserted together in the sleeve **3100**.

[0076] In one embodiment, the cutting device **100** is inserted between the tissue layers while the support rod **3000** is not inserted in the sleeve or inserted only to such extend that the cutting blade **3001** is not protruding through the slit **3110** of the sleeve **3100**. Insertion of the support rod **3201** raises the cutter rod **3000** into its upper position within the sleeve in which the cutting blade **3001** is protruding through the slit **3110** of the sleeve **3100**. The cutting process of the tissue layer is carried out while the support rod **3201** is fully inserted into the sleeve or inserted into the sleeve to such extend that the cutting blade **3001** protrudes through the slit **3110** of the sleeve **3100** during the entire cutting process.

[0077] **Figure 1** illustrates the situation in which the cutter rod **3000** and the support rod **3201** (not visible in **Figure 1** because it is fully inserted in the sleeve) are inserted in the sleeve. In this situation, to cut a tissue layer through which the cutting blade **3001** cuts, the cutter rod **3000** is pulled back while the support rod **3201** remains in position within the sleeve. To bring the cutter rod **3000** and the cutting blade back into the starting position before the cut shown in **Figure 1**, the support rod **3201** is removed from the sleeve **3100**. Removing the support rod **3201** brings the cutter rod **3000** back into its lower position in which the cutting blade **3001** is hidden within the sleeve **3100** or in other words in which the cutting blade **3001** is not protruding through the slit **3110** of the sleeve to avoid damaging surrounding tissue. To repeat the process the support rod **3201** is re-inserted into the sleeve **3100** to bring the cutting rod **3000** back into its upper position in which the cutting blade **3001** protrudes through the slit **3110** of the sleeve **3100**.

[0078] As shown in **Figures 1** and **4**, the support rod **3201** can be connected to a handle 3005 which allows the practitioner to easily insert the support rod **3201** into the sleeve **3100**. The handle provides a through hole which fits the size of the cutter rod **3000**. As illustrated in **Figure 1**, the through hole in the handle **3005** allows inserting the support rod **3201** into the sleeve while the cutter rod **3000** is already inserted in the sleeve **3100**. The handle **3005** can have any shape which allows easy handling of the support rod guiding member **3003**. In the illustration of **Figure 4**, the support rod guiding member **3003** comprising the handle **3005** and the support rod **3201** has a rectangular block shape wherein the upper corners and/or the lower corners are rounded.

[0079] As shown in the inset of **Figure 2**, the sleeve **3100** can comprise a double slit, i.e. two slits **3110** located on opposite sides of the sleeve **3100**. However, it is also possible that the sleeve **3100** comprises only one slit **3110** as shown for example the embodiment illustrated in **Figure 13**.

[0080] In the embodiment illustrated in **Figures 1** to **5**, the support rod **3201** and the cutter rod **3000** have a semicircular shape. However, the shape of the support rod **3201** and the cutter rod **3000** is not limited to a semicircular shape. The shape of the support rod **3201** and the cutter rod **3000** can have any shape as long as the shape is complementary to each other, i.e. the support rod **3201** and the cutter rod **3000** together form a shape which allows insertion into the sleeve and protruding of the cutting blade through the slit of the sleeve when both support rod and cutter rod are inserted in the sleeve. **Figure 6** illustrates further possible shapes for the support rod and cutter rod. **Figure 6 (A)** illustrates the example also shown in

Figure 1. In **Figure 6 (B)** the cutter rod **2** and the support rod **6** have an irregular shape but their shapes are complementary to each other and form a full circle. It would also be possible that in case a rectangular sleeve is used the support rod and the cutter rod form together a rectangular form or even a circular form as long as the resulting form fits into the sleeve and allows the cutting blade to protrude through the slit of the sleeve.

[0081] The slit on the sleeve is extending from a first end of the sleeve towards the second end. The length of the slit can vary. The length of the slit may be adapted to conform to the length of the cut which one intends to make using the cutting device **100** of the present invention. The length of the slit determines the distance that the cutting blade **13** on the cutting rod **2** can cover. For example, the slit can extend from the first end of the sleeve at which also the tip is connected to about 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 % of the entire sleeve.

[0082] The cutting blade **13, 3001** can have any shape as long as it is suitable to pierce through a tissue or tissue layer and cut the respective tissue or tissue layer, such as the pulley **130** in case of releasing a trigger finger. In one embodiment, the blade edge of the cutting blade is pointing away from the first end of the sleeve, i.e. the end with the tapered shape or the end to which the tip **1, 3002** is mounted. Thus, the blade edge is facing the second end of the sleeve which is the end through which the cutting rod **2, 3000** and the support rod **6, 3201** are inserted into the sleeve. The blade **13, 3001** can be made of any known material which is known for the manufacture of knifes, such as ceramic materials or stainless steel. In one embodiment, the blade is obtained from the tip of a blade used for scalpels.

[0083] In another embodiment, the cutting device **100** may further comprise a housing **10** comprising a first end and a second end as illustrated for example in **Figures 7** and **8**. The housing **10** can be connected at the first end to the sleeve **3**. The housing **10** may comprise a movable cutter holder **8** and a movable support rod holder **7**. The cutter holder **8** may support the cutting rod **2**, and the support rod holder **7** may support the support rod **6**. The cutter holder **8** and the support rod holder **7** may be movable independently from each other. During use, a movement of the cutter holder **8** within the housing **10** allows moving the cutter rod **2** attached to it within the sleeve **3** and a movement of the support rod holder **7** allows moving the support rod 6 within and out of the sleeve **3**.

[0084] While the principal working mechanism for cutting of tissue or a tissue layer is the same as described for the embodiment of the cutting device shown in **Figure 1**, this further embodiment comprises a semi-automated cutting mechanism. This mechanism enables the

practitioner to conduct the cutting process by simply exerting a force on the release mechanism of the cutting device **100** described herein after it has been positioned in the affected are of the body.

[0085] Therefore, the cutting device **100** illustrated in **Figure 8 (A)** and **8 (B)** may comprise in addition to the tip **1**, the cutter rod **2**, the sleeve 3 and the support rod **6**, a housing **10** comprising a front cap **11** and an end cap **4**. Within the housing may be comprised a guiding member **9** which again wraps around a cutter holder **8** and a support rod holder **7**. Between the cutter holder **8** and the front cap **11** a tensible member, in this case a spring **5**, may be arranged. The spring **5** serves to activate the semi-automated release mechanism which upon its release draws back the cutting rod **2** through the sleeve **3** and thus the cutting blade **13** which carries out the cut of the tissue or tissue layer.

[0086] For cocking of the release mechanism the tensible member **5** arranged between the front cap **11** of the housing **10** and the cutter holder **8** is compressed. The cutting rod **2** is attached to the cutter holder **8**. Compression of the tensible member **5** is achieved by pushing the cutter holder **8** towards the first end of the housing, i.e. towards the front cap **11**. The forward movement of the cutter holder 8 moves the cutter blade **2** towards the first end of the sleeve **2**. After compression of the tensible member **5**, the cutter holder **8** may be arrested in the cocked position through side members **84** which engage the engaging region **122** of a side guide **12** via a protrusion **83** located at the front end of the cutter holder **8** facing the front cap **11**. In this cocked condition the cutting device can be inserted at the affected area of the body. However, it is also possible to cock the release mechanism for the cutter rod **2** after insertion of the cutting device **100** at the affected area of the body. Once the cutter device **100** is placed, the support rod **6** is pushed forward into the sleeve thus raising the cutting blade **13** through the slit **31** of the sleeve **3**. To release the mechanism a force is applied directly to side member **84.** The side member **84** moves towards a central core region **80** of the cutter holder thus disengaging the protrusion **83** which engages the engaging region **122** of the side guide **12**. Upon disengaging the compressed tensible member **5** relaxes and moves the cutter holder **8** towards the second end of the housing **10**, i.e. towards the end cap **4** of the housing **10**. In other words, as result of the disengagement, the cutter holder **8** is pushed back by the uncocked tensible member **5** towards the second end of the housing **10**. This backwards movement of the cutter holder **8** moves the attached cutting rod **2** and the cutting blade **13** protruding through the slit **31** backwards which causes the cut of the overlying tissue or tissue layer by the cutting blade **13** protruding through the slit **31**.

[0087] **Figures 11** and **12** show for example details of the components which form part of the release mechanism described herein. In **Figures 11** and **12**, a front cap **11** is attached to the housing **10**. The side of the front cape facing the inside of the housing comprises an opening **1110** through which the cutter rod **2** and the support rod **6** can be introducible into the sleeve **3**. The cutter rod **2** is attached to the cutter holder **8** and the support rod **6** is attached to the support rod holder **7**, which is located in direct proximity to the cutter holder **8** (not shown in **Figures 11** and **12**) within the guiding member **9**. In Figure **11** the guiding member **9** has been moved aside to illustrate the positioning of the cutter rod **2** and the support rod **6** within the housing **10**.

[0088] The front cap **11** of the housing further comprises a contact area for the tensible member which may be located directly above the opening **1110** for the cutter rod **2** and the support rod **6**. This contact area can be a depression comprised in the front cap as shown in **Figure 11** but can also be a protrusion which functions like a flange or fitting for positioning the tensible member in its position at the front cap **11**. The tensible member **5** may be attached to the front side of the cutter holder **8** in the same manner as the tensible member **5** is attached to the front cap **11** of the housing **10**. In one embodiment illustrated in **Figure 10** and **22(B)**, the depression can extend into an opening or recess **86** which envelopes a section of the tensible member **5**.

[0089] The opening **86** in the central core region **80** of the cutter holder **8** may not extend through the entire length of the cutter holder **8** but only to an extent sufficient for the tensible member **5** to be securely supported by the cutter holder **8** so as to avoid derailing of the tensible member **5** upon movement of the cutter holder **8** towards the front cap **11** of the housing **10**. The opening **86** can have any shape as long as it sufficiently supports the tensible member **5**. **Figure 12** illustrates a situation in which the uncocked tensible member is attached to the front cap via contact to the contact area **1111** of the front cap **11** on the one side and to the cutter holder **8** via insertion through the opening **86** into the cutter holder **8**.

[0090] **Figure 18** illustrates close up views of the front cap **11** to be attached to the housing **10** of the cutting device **100**. The front cap **11** has a shape which allows it to be fit to the housing **10** of the cutting device **100**. At the side which is facing inside the housing **10**, the front cap comprises an opening **1110** which extends through the front cap to the front side thereof **1114**. As illustrated in **Figure 18 (A)**, the front side of the cap **11** comprises a connecting member **1113** in form of a protrusion with a narrowed end section for fitting in the sleeve **3**. The connecting member **1113** serves as a track guide for the cutter rod **2** and the

support rod **6** which can be inserted in and out of the sleeve **3** via the opening **1110** and **1114** of the front cap **11**. The front cap further comprises orifices **1112** for fixation means, such as screws, rivets or pins which can be used to attach the front cap to the housing **10**. The diameter of the through-hole through the front cap may narrow from a larger diameter at the opening **1110** at the back side of the front cap **11** to the opening **1114** at the front side of the front cap **11** for guiding the cutting rod **2** and the support rod **6** into the connected sleeve **3**.

[0091] Besides the mounting spot for the tensible member at the cutter holder **8**, **Figures 22A** and **22B** show further elements which may form part of the release mechanism. The cutter holder **8** can be divided in a central core region **80** which is separated either to one side or to both sides via slits in the cutter holder from the side member(s) **84**. The slit(s) **82** extends from the front end of the cutter holder **8** to a section near the end of the cutter holder 8 and separates a section of the cutter holder along a vertical axis from the bottom to the top to form a flexible side member(s) at the side of the cutter holder.

[0092] The side member(s) **84** thus formed may be thinner that the central core region **80**. The side member(s) **84** has a thickness which allows it to easily move the side member(s) **84** towards the central core region **80** upon exertion of a force on the side of the side member **84** facing away from the central core region **80**. Therefore, the side member **84** can also be referred to as resilient member **84**.

[0093] The side member(s) **84** comprises at its front section which is pointing towards the front cap **11** of the housing a protrusion **83**. The protrusion **83** is formed on the side member(s) **84** in a position which allows the protrusion **83** to engage a part of the cutting device **100** upon cocking of the tensible member **5** to arrest the cutter holder **8** in the cocked position. Upon compression of the tensible member **5** and thus movement of the cutter holder **8** towards the front cap of the housing **11**, the side member(s) **84** and thus the protrusion **83** at each side member(s) **84** catch or engage an engagement region of the housing **10**. In one embodiment, the engagement region is arranged on a side guide **12** which is either mounted to the housing **10** or forms an integral part of it. Engagement of the protrusion **83** of the side (resilient) member **84** fixes the position of the cutter holder **8** when it is cocked, i.e. the cutter holder **8** is moved towards the first end of the housing carrying the front cap **11** while the tensible member **5** is positioned between first end of the housing and cutter holder **8** (see for example **Figures 12** and **13**).

[0094] An embodiment of a side guide comprising an engaging region which can be used as fixture for the cutter holder **8** is illustrated in Figure **12**. In general the side guide can have

any shape as long as it provides an engagement region for the side member **84** of the cutter holder **8**. In one embodiment, a side guide **12** has a rectangular shape with two stabilizing extensions **19** at each end of the side guide **12**. The stabilizing extensions **19** may have a rectangular shape and being dimensioned to stabilize the position of the cutter holder **8** and the support rod holder **7** when attached to the housing **10** or to stabilize the position of the guiding member **9**, if present, in the housing **10**. The side guide may comprise orifices **121** for fixing the side guide **12** to the housing **10** using fixation means described herein. As shown for example in **Figures 10**, **12** and **13**, the side guide can be connected to the housing **10** via a connecting beam **2001** located at the side of the housing which comprises orifices **2002** congruent in their orientation to the orifices **121** of the side guide **12**. In another embodiment the side guide **12** is connected directly to the housing **12** without using a connecting beam **2001**.

[0095] In another embodiment, the side guide **12** shown in **Figure 25** may have the shape of a rectangular thin plate mounted to either one or both sides of the housing **10** without using stabilizing extensions **19**. The rigidity of the side guide **12** is adapted to allow movement of the side guide towards the cutter holder to exert a force on the side member **84** of the cutter holder **8** to release the cocked tensible member **5** attached to the cutter holder **8**. In one embodiment the rigidity of the side guide **12** may be adapted only in the section comprising the engagement region **122**. In an alternative embodiment in which the side guide **12** is connected to the housing **10** via a beam **2001**, the beam may be made of a flexible material while the side guide **12** is of a rigid or stiff material. An exertion of force on the side guide **12** will then result in a movement of the side guide **12** due to the compression of the flexible beam **2001** rather than a deformation of the side guide **12**.

[0096] Instead of using a side guide 12, the housing **10** can be shaped to comprise a flexible side portion comprising an engagement region for temporarily fixing the position of the cutter holder **8** when in its cocked position before release.

[0097] The support rod holder **7** is illustrated for example in **Figures 9**, **16** and **17**. Like the cutter holder **8**, the support rod holder **7** comprises a mounting point for the support rod **6**. The support rod holder **7** comprises recesses **72** which are adapted to take up the support rod **6**. In one embodiment, the mounting point can have the shape of a dumbbell, i.e. two rectangular shaped recesses connected by a middle section **73**. The rectangular shaped recesses **72** are sunken deeper into the surface of the support rod holder **7** than the connecting middle section **73**. The connecting middle section **73** can have a U-shaped profile as illustrated for example

in **Figure 16B**. Due to the use of two recesses connected by another higher elevated recess (middle section **73**), an abutment is formed for fixing the support rod **6**.

[0098] As illustrated for example in **Figure 15**, the support rod **6** having a first end **61** comprises a groove **62** at the opposite end. The length and depth of the groove **62** is complementary to the length and depth of the connecting middle recess **73** of the support rod holder **7**. Thus, when placed in the recess of the support rod holder **7**, the support rod **6** is flush with the surface of the support rod holder **7**. This connection further allows that the support rod **6** moves whenever the support rod holder **7** is moved within the housing **10**. A similar structure can be found for the cutting rod **2** which is attached to the cutter holder **8**. As illustrated in **Figure 22A**, the cutter holder **8** can also comprise recesses **81** connected by a middle section **87**. A groove **21** at the end of the cutting rod **2** (see for example **Figure 14**) allows attaching the cutting rod **2** to the cutter holder **8** in the same manner as the support rod **6**.

[0099] As alternative, any other method for fixing those components together can be used. For example, for permanently fixing it is also possible to weld the cutting rod **2** and the support rod 6 to the cutter holder 8 and the support rod holder 7, respectively. The support rod **6** and the cutting rod **2** can be attached to the cutter holder **8** and the support rod holder **7** in the same manner or by different means, respectively.

[00100] **Figure 23** shows a schematic view of a guiding member **9** which may be comprised in the housing **10**. As illustrated in **Figures 10**, **12** and **13**, a guiding member **9** may support the cutter holder **8** and the support rod holder **7** and can serve as a track or guard rail for the cutter holder **8** and the support rod holder **7**. The cutting device **100** can also be designed without a guiding member **9** in case the housing is formed to take over the part of the guiding member **9** illustrated in the embodiment shown in the above Figures. Thus, depending on the design of the housing the use of the guiding member is optional.

[00101] In the embodiment of the guiding member **9** shown in **Figure 23**, the guiding member **9** comprises a front end with a first opening **93** and a back end with a second opening **92**. The guiding member **9** can have a round shape. The guiding member **9** may further comprise recesses **94** or mounting points for screws, pins, etc. (not shown) for fixing the position of the guiding member **9** within the housing **10**. The recesses **94** can be positioned at the side of the guiding member **9** facing the inner side of the housing **10** within which the guiding member **9** is positioned. In another embodiment, the guiding member **9** does not comprise recesses **94**. The guide member **9** is being located between the front cap **11**, end cap

4 and the side guide **12**. Slight vertical movement of the guide member **9** within the housing **10** is allowed and does not negatively effect the operation of the device and thus recesses **94** are not necessary.

[00102] The guiding member is in the form of a hollow tube with two strut members connecting a round front section forming the opening **93** with another round back section which forms the opening **92**. The two strut members are formed like an arc to be corresponding with the curvature of the round front section and the round back section of the guiding member **9** which the two strut members connect.

[00103] In addition, a round opening **91** can be formed on one side or on both sides of the guiding member **9**. The round opening **91** is adapted to give space to the thumb and index finger which are used to activate the cutting mechanism. The round opening **91** is a cut-out formed on the front side by the round front section of the housing which forms the opening **93**, and the two strut members which connect the round front section and the round back section of the guiding member **9**. The position of the round opening(s) **91** is corresponding to the position of the cutter holder **8** when in its cocked position. Thus, in the cocked position, the protrusion(s) of the side member(s) **84** engaging the engagement region **122** of the side guide **12** come to rest in a position which is corresponding to the position of the round opening(s) **91** in the guide member **9**. The opening(s) **91** provides the necessary space which allows to exert a force onto the side member 84 which moves towards the central core region **80** of the cutter holder **8** which then results in the release of the cocked cutter holder **8**.

[00104] If present in the cutting device **100**, the diameter of the guiding member **9** is smaller than the diameter of the housing **10** to allow placement of the guiding member **9** within the housing **10**. The components of a cutting device **100**, such as the guiding member **9**, the housing **10** and the cutter holder **8** are designed to define in their assembled configuration a rectangular space located between the front section of the housing **10** and the end section of the housing as illustrated for example in **Figure 7** and **13**. This rectangular space defined by those components serves to mount the side guide **12** (see **Figure 7**) which is used to locate and guide the guiding member 9. As can be seen in a top view of a cutting device shown for example in **Figure 28A**, this results in a narrower rectangular middle section of the cutting device **100** connecting two broader end sections. This design ensures easily handling of the device by a practitioner.

[00105] In this regard, the housing **10** shown in **Figure 24** also may have a round shape but can also be of any other shape which can be easily handled by a practitioner. For example, the

shape of the housing can be more ergonomic to facilitate the practitioners grip on it during use. The housing comprises mounting points **14** for attaching the components of the housing to the frame of the housing **10** using screws or rivets or pins, to name only a few. The mounting points **14** for the front cap **11** are located in the round front section of the housing **10** and their position is corresponding to the position of the orifices **1112** at the outer perimeter of the front cap **11** which fits into the front opening of the housing **10**. The mounting points **14** for the end cap **4** are located in the round end section of the housing **10** and their position is corresponding to the position of the orifices **43** at the outer perimeter of the end cap **4** which fits into the back opening of the housing **10**.

[00106] The housing **10** is formed in almost the same manner as the guiding member **9** which can in one embodiment resemble the form of the housing **10**. The housing may have the shape of round tube with a front section formed by an annular ring which forms a first opening **15**. This first opening is for insertion of the front cap **11** which is connected to the sleeve 3. The back section of the housing **10** may also have the shape of an annular ring wherein the annular ring may be more expanded along the horizontal axis than the front section. The annular back section receives the end cap **4**. The annular back section forms a second opening **16** which forms the back end of the housing **10**.

[00107] Like for the guiding member **9**, the round front section and back section of the housing **10** are connected by strut members. These strut members comprise the mounting points **14** for fixing the position of the guiding member **9** within the housing **10** if present. As indicated by the designation as 'struts', the two struts do not encase the interior of the housing but leave an open space at two sides of the housing **10**. It is possible that only one strut is formed which leaves only one opening at one side of the housing. This embodiment would be useful in case the release mechanism for the cutter holder **8** comprises only one side member **84** which needs to be moved towards the central core region **80** of the cutter holder **8** to release the cocked spring **5**.

[00108] The width of the two struts is also adapted to allow mounting of one or two of the connectors **2001** which can be used for mounting the side guide **12** to the housing. The round front section of the housing comprises a semicircular indentation **18** at the side of the front section facing the side which is opposite to the side to which the front cap **11** is attached. The semicircular indentation **18** can be formed at one side of the housing or on both sides. Like the round opening area **91** at the guiding member **9**, the semicircular indentation is formed to

provide space for direct access to the side member **84** which is necessary to operate the release mechanism for the cocked cutter holder **8** described above.

[00109] Other than to allow the direct application of force onto the side member **84** by pressing with a thumb and/or the index finger on it, the space should be sufficient to provide a firm grip for the practitioner so that the thumb and/or index finger does not slip while pressing which might change the position of the cutting blade **13** and thus the correct position at the affected area in the body of the patient.

[00110] **Figure 9** illustrates the relative position, size and shapes of the cutter holder **8** and the support rod holder **7** relative to each other in one embodiment of the present invention. In general, the cutter holder **8** and the support rod holder **7** should complement each other to form a shape which in the assembled configuration easily fits into the housing **10** or the guiding member **9**. Furthermore, the cutter holder **8** holding the cutting rod **2** (not shown in **Figure 9**) and the support rod holder **7** holding the support rod **6** need to be arranged relative to each other so that the cutter rod **2** and the support rod **6** are positioned in direct proximity to each other to form the complementary shape which fits into the sleeve **3** of the cutting device **100**.

[00111] In one embodiment, the support rod holder has a semicircular shape with the support rod **6** mounted at the flat surface of the semicircular support rod holder **7** which is facing the flat surface of the also semicircular cutter holder **8**. Thus, when placed together in the housing **10** or the guiding member **9** the cutter holder **8** and the support rod holder **7** form a circular shaped assembly. A configuration of such an assembly with a semicircular cutter rod **2** and a semicircular support rod **6** is illustrated for example in **Figures 11** and **12** (support rod holder **7** not visible in **Figures 11** and **12**).

[00112] The cutter holder **8** and the support rod holder **7** do not necessarily have to form a circular shape together. For operation of the cutting device **100** it is sufficient when the shape of the cutter holder **8** and the support rod holder **7** are adapted so that that cutter rod **2** and the support rod **6** are in proximity to each other so that they can be easily moved in and out of the sleeve **3** together or separately from each other.

[00113] **Figure 9** also illustrates the sizes and relative positions of the cutter holder 8 and the support rod holder **7** to each other in one embodiment of the present invention. The cutter holder **8** and the support rod holder **7** are movable independently to each other along a horizontal axis within the housing **10** or guiding member **9** of the cutting device **100**. The position of the support rod holder **7** depends on whether the support rod **6** is inserted into the

sleeve **3** or not. In case the support rod **6** is to be introduced into the sleeve **3**, the support rod holder **7** is moved towards the front of the housing **10**. Referring to **Figure 9** this would mean that the support rod holder **7** is moved in the direction of the protrusion **83** which can be seen in **Figure 9**. This movement would move the support rod **6** shown in **Figure 9** through the opening **1110** of the front cap **11** of the housing **10** into the sleeve **3**. A position of the support rod holder **7** in which the support rod **6** attached to it is inserted into the sleeve is necessary in case the practitioner intends to raise the cutting blade **13** mounted at the front end of the cutter rod **2** to carry out a cut in the overlying tissue or tissue layer. As shown in **Figure 9**, the support rod holder **7** can be moved freely along the bottom surface of the cutter holder **8**. In the fully assembled cutting device **100** (see for example **Figure 7**), the cutter rod **2** is normally at least partially inserted in the sleeve while the support rod is only introduced into the sleeve in case the practitioner wishes to raise the cutter rod **2** so that the cutting blade **13** protrudes through the slit **31** of the sleeve 3 for cutting tissue or a tissue layer.

[00114] In another aspect the present invention refers to a control rod **550** and a retrieval rod **500**. The control rod **550** may have two functions. The first function may be to move the cutter holder **8** towards the front cap **11** of the housing **10** of the cutting device **100** until the protrusion **83** on the side member **84** of the cutter holder 3 engages the engagement region **122** of the side guide **12**. The second one being moving the support rod holder **7** towards the front cap **11** of the housing **10** of the cutting device **100** to insert the support rod **6** into the sleeve **3** connected to the front cap **11** of the housing **10**.

[00115] Therefore, the control rod **550** has to be adapted to be engageable with the cutter holder **8** as well as with the support rod holder **7**. To engage the cutter holder **8** the control rod **550** is inserted through an opening in the end cap **4** of the cutting device **100**. The end cap comprises two openings, a first opening **42** and a second opening **41**. To move the cutter holder **8** the control rod **550** is inserted through the first opening **42** into the cutting device **100**. The position of the first opening **42** in the end cap is aligned with the position of the cutter holder **8** in the housing **10**. The control rod **550** either contacts the cutter holder 8 at its back end which faces the end cap **4** or in alternative shown in **Figure 22A** is inserted through an opening **85** at the back end of the cutter holder **8** into the cutter holder **8** to contact a point inside the cutter holder **8**. The round or rectangular opening **85** at the back side of the cutter holder **8** can have a cone like shape, i.e. the diameter narrows until it ends into a fixed point inside the cutter holder **8** onto which the control rod **550** comes to rest. In one embodiment,

the contact point of the control rod is formed like the contact area **1111** for the spring **5** in the front cap **11** of the cutting device **100**.

[00116] To avoid introducing the control rod **550** to deep into the housing and thus risk overcompression of the tensible member, the control rod comprises two different sections **559** and **558** having different diameters. The first section of the control rod **559** located at its front end has a diameter which is adapted to fit through the first opening **42** of the end cap **4**. However, the second section **558** has a diameter which exceeds the diameter of the first opening **42** of the end cap **4**. Thus, the control rod **550** can only be inserted into the housing **10** through the first opening **42** to the end of the first section **559**.

[00117] The diameter of the second section **558** of the control rod **550** is however adapted to fit through the second opening **41** of the end cap **4**. The position of the second opening **41** is aligned with the position of the support rod holder **7** in the housing **10**. Thus, when inserting the control rod **550** through the second opening **41** the control rod **550** can engage the back end of the support rod holder **7**, which faces the end cap **4** of the housing. Upon contact of the front end of the control rod **550** with the support rod holder **7**, the support rod **6** can be moved towards the front cap **11** of the housing **10**. Thus, the support rod **6** attached to the support rod holder **11** is moved into the sleeve **3**. As shown in **Figure 9**, the distance between the front end of the support holder **7** and the front cap **11** is much larger than the distance between the longer cutter holder **8** and the front cap **11**. Therefore, the control rod **550** is inserted much deeper into the housing **10** to move the support rod holder **7** all the way to the front of the housing **10** near the front cap **11** and the sleeve **3**. This is also illustrated in **Figure 28A** and **28C** in which it can be seen that the control rod **550** is inserted until the end of the second section **558** into the housing **10** (see **Figure 28C**) when inserted into the housing **10** through the second opening **41**. In comparison in **Figure 28A** the control rod **550** is inserted only until the end of the first section **559** into the housing **10**.

[00118] The control rod **550** moves the cutter holder **8** into the position near the front cap **11**. This movement also cocks the spring and thus activates the automatic release mechanism of the device used for carrying out the cut of the tissue with the cutting blade **13**. Thus, upon release of the cocked spring the cutter holder **8** is moving automatically back into the starting position by force of the relaxing spring **5**. In contrast, the control rod **550** can move the support rod holder **7** into the position near the front cap **11**. Since the support rod holder **7** is withdrawn manually and not via an automatic mechanism like the cutter holder **8** the retrieval rod **500** is used in one embodiment of the present invention. The retrieval rod is used to

withdraw the support rod holder **7** into its starting position near the end cap **4** of the cutting device (see for example **Figure 9**).

[00119] Therefore, the retrieval rod **500** comprises a front section **502** which is adapted to engage a section of the support rod holder **7** which is positioned on the opposite end of the support rod holder 7 at which the support rod **6** is mounted. In one embodiment, the front section **502** of the retrieval rod **500** comprises a thread which allows screwing the retrieval rod **500** into an opening **71** of the support rod holder **7** (see for example, **Figure 9** and **16B**). After connecting the retrieval rod to the support rod holder **7**, the support rod holder **7** can be moved in its starting position by moving the retrieval rod **500** backwards through the opening **41** of the end cap **4**. The diameter of the front section 502 of the retrieval rod is adapted to fit into the opening **71** of the support rod holder. The retrieval rod **500** comprises a connecting section **501**. The diameter of the connecting section is adapted to fit through the opening **41** of the end cap but not through the opening **42** of the end cap. Selection of different diameters for the openings **41** and **42** of the end cap **4** and different diameters used for the control rod **550** and the retrieval rod 500 avoid that the practitioner mistakenly chooses the wrong opening for insertion of either the control rod **550** or the retrieval rod **500**.

[00120] The control rod **550** and/or the retrieval rod **500** may further comprise a handle **556** and **557**, respectively, which can be attached to the end of the control rod **550** or the retrieval rod **500** for ease of handling.

[00121] In another aspect, the present invention refers to a system comprising a cutter device described herein as well as a control rod and a retrieval rod described herein. Furthermore, such a system can also comprise an ultrasound device, such as a high-frequency ultrasound device operating at 17 MHz for checking the position of the sleeve of the cutting device into the affected are of the body. Sonographically assisted techniques for determining the position of a device within the human body are known in the art. For example, Jou, I.M. and Chern, T.C. (2006, Journal of Hand Surgery (British and European Volume), vol.31B, no.2, pp.191) describe a sonographically assisted percutaneous technique for releasing trigger digits which provides direct visualization.

[00122] **Figure 28** describes an exemplary embodiment illustrating the use of the different components of a system referred to herein for the operation of a cutting device described herein. At first the control rod **550** is inserted into the cutting device to cock the spring **5** and bring the cutter holder **8** and the cutter rod **2** in its forward position (**Figure** 28A). After cocking of the device the cutting blade **13** of the cutter rod **2** is positioned at the beginning of

the sleeve **3** at the tip **1** of the sleeve. However, the blade **13** is not yet visible because it is still hidden within the sleeve **3** (no support rod inserted). After cocking of the spring the control rod **550** is withdrawn and the cutting device **100** is now ready for insertion at the affected area of the body (**Figure 28B**).

[00123] After positioning the cutting device **100** at the correct position at the affected area of the body, the cutting blade **13** needs to protrude through the slit **31** of the sleeve **3** to be able to cut through the overlying tissue. Therefore, the control rod is fully inserted through the opening **41** of the end cap **4** into the cutting device **100**. Insertion moves the support rod holder **7** towards the front end of the cutting device and thus the support rod **6** into the sleeve **3**. Insertion of the control rod **6** into the sleeve **3** raises the cutting blade **13** which then pierces through the overlying tissue or tissue layer (see **Figure 28C**). Afterwards the control rod is removed.

[00124] To cut the desired length of the overlying tissue or tissue layer the cutting blade **13** now needs to be moved backwards. This is achieved in the present embodiment by releasing the spring. Releasing the spring by pressing on the side member **84** of the cutter holder **8** moves the cutter holder **8** towards the end cap **4** of the cutting device. This movement moves the cutter rod **2** and the cutting blade **13** mounted on it backwards and results in cutting the overlying tissue or tissue layer (see **Figure 28D**).

[00125] After the cut has been carried out, the cutting device needs to be removed. However, before removing the cutting device the cutting blade **13** is lowered back into the sleeve to avoid damaging the surrounding tissue when removing the cutting device from the body. Therefore, the retrieval rod **500** is inserted into the device **100** through the opening **41** in the end cap of the cutting device **100**. The retrieval rod **500** engages the support rod holder **7** through the opening **71**. Moving the support rod holder **7** backwards removes the support rod **6** out of the sleeve **3** (see **Figure 28E**). Now the cutting rod **2** with the cutting blade **13** sinks back into its lower position within the sleeve **3** in which the cutting blade **13** does not protrude through the slit **31** (see **Figure 28F**). Afterwards the cutting device can be safely removed without damaging the surrounding tissue.

[00126] The same operation can also be carried out with the cutting device illustrated in **Figure 1**.

[00127] In further embodiments, the shape of the sleeve can be curved which would allow to reach positions within the body which cannot easily be reached with a straight sleeve. In

this case the support rod **6** and the cutter rod **2** can be made of flexible materials which allow their movement around bends or curves in the sleeve.

[00128] The cutting device and its components can be made of any material which is used for apparatuses in clinical applications. For example, the devices described herein can be made of materials which are easily sterilized, such as stainless steel, titanium and plastic.

[00129] The inventions illustratively described herein may suitably be practiced in the absence of any element or elements, limitation or limitations, not specifically disclosed herein. Thus, for example, the terms "comprising", "including", "containing", etc. shall be read expansively and without limitation. Additionally, the terms and expressions employed herein have been used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed. Thus, it should be understood that although the present invention has been specifically disclosed by preferred embodiments and optional features, modification and variation of the inventions embodied therein herein disclosed may be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this invention.

[00130] The invention has been described broadly and generically herein. Each of the narrower species and subgeneric groupings falling within the generic disclosure also form part of the invention. This includes the generic description of the invention with a proviso or negative limitation removing any subject matter from the genus, regardless of whether or not the excised material is specifically recited herein.

[00131] Other embodiments are within the following claims and non- limiting examples. In addition, where features or aspects of the invention are described in terms of Markush groups, those skilled in the art will recognize that the invention is also thereby described in terms of any individual member or subgroup of members of the Markush group.

LIST OF REFERENCE SIGNS

1	Tip of sleeve
2	Cutting rod
3	Sleeve
4	End cap of housing
5	Spring
6	Support rod
7	Support rod holder
8	Cutter holder
9	Guiding member
10	Housing
11	Front cap of housing
12	Side guide
13	Cutting blade
14	Mounting point
15	First opening of housing
16	Second opening of housing
17	Connecting collar
18	Semicircular indentation in front section of the housing
19	Stabilizing extension
21	Groove for attaching cutting rod to cutter holder
31	Slit
32	Opening at first end of sleeve
41	Second opening in end cap
42	First opening in end cap
43	Opening for fixation means
61	Front end of support rod
62	Groove for attaching support rod to support rod holder
71	Opening for retrieval rod
72	Recess for attachment to support rod
73	Connecting recess
80	Central core region
81	Recess for holding cutting rod

82	Slit in cutter holder
83	Protrusion for engaging side guide
84	Side member
85	Opening in cutter holder for inserting control rod
86	Opening for spring
87	Connecting recess
91	Rounded opening area for side guide
92	Opening of guiding member towards end cap
93	Opening of guiding member towards front cap
94	Contact point for fixation means
121	Opening for fixation means
122	Engagement region of side guide
130	Pulley
135	Tenosynovium
140	Tendon
145	Bone
500	Retrieval rod
501	Connecting section between handle and tip of retrieval rod
502	Front section of retrieval rod
550	Control rod
556	Handle
557	Handle of retrieval rod
558	Second section of control rod
559	First section of control rod
1110	Opening in front cap for support rod and cutting blade
1111	Contact area for spring
1112	Opening for fixation means
1113	Connecting member
1114	Opening for inserting sleeve
2001	Beam for connecting side guide
2002	Hole for inserting fixation means
3000	Cutting rod
3001	Cutting blade

3002	Tip of sleeve
3003	Support rod guiding member
3004	Positioning member
3005	Handle of support rod guiding member
3100	Sleeve
3110	Slit in sleeve
3201	Support rod

CLAIMS

1. A cutting device for cutting tissue comprising:
   - a sleeve having a first end and a second end, the sleeve comprises a slit extending from a position at the first end of the sleeve and wherein the first end of the sleeve is shaped to allow insertion of the sleeve between two tissue layers;
   - a cutting rod carrying a cutting blade at a first end, the cutting rod being insertable into the sleeve through the second end of the sleeve and being movable within the sleeve; wherein the cutting rod is positioned within the sleeve so that the cutting blade can protrude through the slit of the sleeve; and
   - a support rod, the support rod being insertable into the sleeve through the second end of the sleeve and being movable within the sleeve;

   wherein the cutting rod and the support rod fit together into the sleeve; and wherein when the cutting rod and the support rod are arranged together within the sleeve the cutting blade of the cutting rod is protruding through the slit of the sleeve.

2. The cutting device of claim 1, wherein the cutting rod and the support rod are independently of each other movable within the sleeve and insertable in the sleeve.

3. The cutting device according to claim 1 or 2, wherein the cutting rod and the support rod fill out the entire space of the sleeve when fully inserted into the sleeve during use.

4. The cutting device of claim 3, wherein the shape of the cutting rod and the shape of the support rod is the same.

5. The cutting device of claim 3, wherein the shape of the cutting rod and the shape of the support rod is different from each other.

6. The cutting device of claim 4 or 5, wherein the sleeve is round.

7. The cutting device of any one of the preceding claims, wherein the cutting rod and the support rod have a semicircular shape.

8. The cutting device of any one of the preceding claims, wherein the first end of the sleeve comprises a tip with a tapered shape.

9. The cutting device of claim 8, wherein the first end of the sleeve comprises a tip beveled along a vertical axis.

10. The cutting device of any one of the preceding claims, further comprising a housing comprising a first end and a second end and being connected to the sleeve via the first end;

wherein the housing comprises a movable cutter holder and a movable support rod holder;

wherein the cutter holder supports the cutting rod and the support rod holder supports the support rod;

wherein the cutter holder and the support rod holder are movable independently from each other during use; and

wherein a movement of the cutter holder within the housing allows moving the cutting rod within the sleeve and a movement of the support rod holder allows moving the support rod within and out of the sleeve during use.

11. The cutting device of claim 10, wherein the first end of the first housing is closed with a front cap which is connected to the sleeve and the second end is closed with an end cap.

12. The cutting device of claim 11, wherein the cutter holder and the support rod holder are movably supported by a guiding member and wherein the guiding member is comprised in the housing.

13. The cutting device of any one of claims 10 to 12, further comprising a tensible member positioned between the first end of the first housing and the cutter holder such that a movement of the cutter holder towards the first end of the first housing cocks the tensible member and positions the cutter holder in a cocked position.

14. The cutting device of claim 13, further comprising at least one side guide mounted at a side of the housing and comprising an engaging region located near the first end of the housing; wherein a protrusion located at at least one side of the cutter holder engages the

engaging region of the at least one side guide through an opening of the housing to keep the cutter holder in the cocked position when the tensible member is cocked during use.

15. The cutting device of claim 14 comprising two side guides, wherein the two side guides are positioned at opposing sides of the housing.

16. The cutting device of claim 14 or 15, wherein the cutter holder further comprises at least one slit separating the cutter holder into a central core region and a side member;

wherein the central core region supports the cutting rod and provides a contact region for the tensible member;

wherein the side member comprises the protrusion which engages the engaging region of the at least one side guide to keep the cutter holder in the cocked position when the tensible member is cocked during use; and

wherein the side member is movable towards the central core region from which it is separated by the slit upon exerting pressure on the side member; wherein a movement of the side member of the cutter holder towards the central core region allows to uncock the cutter holder from its cocked position by disengaging the connection between the protrusion and the side guide.

17. The cutting device of claim 16, wherein the cutter holder comprises two slits separating a section of the cutter holder into a central core region and two side members which are located at opposing sides of the cutter holder.

18. The cutting device of any one of claims 10 to 17, wherein the second end of the housing comprises a first opening for inserting a control rod into the device, wherein the first opening is positioned to allow the control rod to engage the cutter holder and to move the cutter holder towards the first end of the housing when inserted into the device.

19. The cutting device of any one of claims 10 to 18, wherein the second end comprises a second opening for inserting a retrieval rod into the device or for inserting a control rod into the device,

wherein the second opening is positioned to allow a retrieval rod to engage the support rod holder and to move the support rod holder towards the second end of the

housing when inserted into the device and thus moving the support rod supported by the support rod holder out of the sleeve; or

wherein the second opening is positioned to allow the control rod to move the support rod holder towards the first end of the housing and thus moving the support rod supported by the support rod holder into the sleeve.

20. The cutting device of any one of claims 1 to 9, wherein the cutting device further comprises a support rod guiding member connected to the support rod and comprising a through hole extending from one end of the support rod guiding member to the other end.

21. The cutting device of claim 20, wherein the cutting rod is adapted to fit through the through hole of the support rod guiding member.

22. The cutting device of any one of claims 1 to 9 and 20 to 21, wherein the sleeve is connected to a positioning member adapted to allow positioning of the sleeve at a specific position in a tissue of a subject.

23. A system for cutting tissue comprising:

- a cutting device of any one of claims 1 to 17;
- a control rod having a first end and a second end, the control rod comprising a first section of a first diameter located at said first end and a second section of a second diameter located at said second end, the second diameter greater than the first diameter; and
- a retrieval rod having a first end and a second end, wherein the retrieval rod comprises an engaging member at the first end of the retrieval rod for engaging the support rod holder of the cutting device.

24. The system for cutting tissue of claim 23 further comprising an ultrasound device.